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Aircraft Accident Report

NASA 712, Convair 990, N712NA
March Air Force Base, California
July 17, 1985

Executive Summary

NASA Aircraft Accident Investigation Board
National Aeronautics and Space Administration
Washington, D.C. 20546

July 1986

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SYNOPSIS

On July 17, 1985, at 1810 P.d.t., NASA 712, a Convair 990 aircraft, was destroyed by fire at March Air Force Base, California. The fire started during the rollout after the pilot rejected the takeoff on runway 32. The rejected takeoff was initiated during the takeoff roll because of blown tires on the right main landing gear. During the rollout, fragments of either the blown tires or the wheel/brake assemblies penetrated a right-wing fuel tank forward of the right main landing gear. Leaking fuel ignited while the aircraft was rolling, and fire engulfed the right wing and the fuselage after the aircraft was stopped on the runway. The 4-man flightcrew and the 15 scientists and technicians seated in the cabin evacuated the aircraft without serious injury. The fire was not extinguished by crash/fire/rescue efforts and the aircraft was destroyed.

FINDINGS

1. The crewmembers were properly certified and qualified for the flight in accordance with NASA Ames Research Center (ARC) policies.

2. The aircraft commander was occupying the right seat and performing copilot duties for this flight. The assigned pilot was seated in the left seat making the takeoff.

3. The aircraft was operated as a public aircraft and was maintained in accordance with Convair 990 maintenance manuals and ARC procedures. Modifications to the aircraft had been made and approved in accordance with ARC airworthiness requirements.

4. The active runway for landing and takeoff at March Air Force Base (AFB), runway 32, is 300 feet wide by 13,300 feet long.

5. The runway was dry and the outside temperature was 85 °F.

6. The taxi distance from NASA 712's parked position on the ramp to the departure end of runway 32 was 2.4 miles. Average taxi speed was about 25 knots.

7. The flightcrew completed the before-takeoff checklist, established takeoff thrust, and began the takeoff at approximately 1,000 feet from the takeoff end of runway 32.

8. The March AFB control tower requested that NASA 712 switch to departure control frequency before takeoff.

9. The cockpit crew was not monitoring March AFB control tower or emergency frequencies during the takeoff.

10. The pilot, after hearing two rapid explosive bangs and associating them with a blown tire, rejected the takeoff. He reduced thrust to idle, deployed the spoilers, and selected reverse thrust on all engines. Reverse thrust was applied about 14 seconds after the pilot heard the first explosive bang.

11. The pilot stated that he decided to use light braking in view of the remaining runway, the suspected blown tire or tires, and his concern with keeping the aircraft aligned on the centerline.

12. The procedures outlined in the ARC flight manuals, available to the pilot, do not directly address rejected takeoffs with blown tires but do state that braking should be used in rejecting a takeoff.

13. The aircraft commander (copilot) did not hold the control yoke forward during the rollout. The resulting light cornering forces on the nose wheel reduced nose wheel steering effectiveness.

14. The main gear tires had been properly inflated, and the brake systems were normal before the takeoff was rejected.

15. The first tire anomaly was failure of the casing on tire 3. The first pieces of casing were found on the runway at about 1,400 feet. The carcass blew at 4,138 feet, immediately after tire 4 failed. Tire 4 failed at 4,125 feet from overloading and heating.

16. A third tire, at the no. 8 position, failed at 6,190 feet, 2,065 feet after tire 4 failed. Tire 8 failed either from overloading or damage from wheel debris.

17. A fourth tire, at the no. 7 position, failed at 7,300 feet, 3,175 feet after tire 4 failed, also from overloading or damage from wheel debris.

18. Tires 3, 4, and 7 were 12 years old. Tire 8 was 9 years old. Tires 3 and 7 were 24-ply rated and tires 4 and 8 were 22-ply rated. Tire 3 was on its sixth retread, tires 4 and 7 on their fourth retreads, and tire 8 on its second retread.

19. A right-wing fuel tank was penetrated, most likely between 6,000 and 7,000 feet down the runway, by an unknown object. Outside witnesses stated that they saw fire on the aircraft at about 7,000 feet, coinciding with the application of reverse thrust. The first signs of fire on the runway surface were at 11,950 feet.

20. The aircraft was stopped at 12,660 feet, 640 feet from the end of the runway and about 30 feet to the right of centerline.

21. The forward and aft left-side aircraft exits were opened, and the slides were used by all occupants to successfully evacuate the aircraft in a timely manner.

22. The control tower operator completed notification to the fire department's alarm room operator (a relief operator was on duty) on the primary crash network at 1810:28. The primary crash network was secured at 1810:51, and the alarm room operator responded to the secondary crash network at 1810:55. He secured the secondary crash network telephone and simultaneously alerted crash/fire/rescue personnel in the fire station at 1811:50.

23. The relief alarm room operator had neither experience in an emergency situation nor hands-on training. His primary duty was as driver of a major CFR vehicle (a P-15 truck).

24. There was an avoidable delay of 1 minute and 22 seconds in dispatching fire equipment.

25. The first crash/fire/rescue vehicle had traversed the 1.6 miles to the accident site and was engaged in firefighting at 1814:24, 3 minutes and 56 seconds after notification.

26. During the firefighting effort, 1,915 gallons of aqueous film-forming foam and 59,000 gallons of water were expended. The fire abated as the right-wing fuel supply was exhausted.

27. Aircraft accident/incident statistics indicate that more rejected takeoffs are due to tire failures than to engine failures.

28. The Board along with Hydro-Aire engineers looked at the operation of the antiskid brake system even though it was not determined to be a factor in this accident. The CV-990 antiskid brake system has pressure control characteristics that pilots should be aware of when braking with failed tires.

PROBABLE CAUSE

The NASA Aircraft Accident Investigation Board determined that the probable cause of the accident was the nearly simultaneous failure of the two front tires on the right main landing gear at a critical time during the takeoff roll. These failures resulted in the pilot's decision to reject the takeoff. Contributing to the severity of the accident was an intense fire fed by leakage from the puncture of a right-wing fuel tank forward of the right main gear; the puncture occurred during the intentional extended rollout of the aircraft.

SAFETY RECOMMENDATIONS

As a result of its investigation of the Convair 990, NASA 712, accident of July 17, 1985, and a review of pertinent background documents and reports, the NASA Aircraft Accident Investigation Board makes the following recommendations.

Federal Aviation Administration

1. Require that flight manuals for large multiengine aircraft provide information on procedures for takeoff emergencies other than engine failure. This information should include guidance for continuing versus rejecting takeoff when an aircraft with all engines operating normally develops anomalies at high speed before reaching V_1, the speed at which a takeoff decision must be made. Factors such as directional control, tire failures, wheel rim failures, antiskid braking characteristics, brake line vulnerability, and fuel tank and structural vulnerability to penetration could be considered. Hazard analyses and risk assessments for various scenarios could be discussed to provide background information for flightcrews to enhance their decision-making during takeoff emergencies.

2. Require that flight manuals for large aircraft specify rejected-takeoff procedures involving tire failures and provide guidance on stopping procedures. Control yoke management procedures to enhance directional control, similar to guidance provided for takeoffs and landings, should be addressed.

3. Sponsor a joint research effort with other appropriate Government agencies to improve firefighting capabilities for running-fuel "three dimensional" fires.

4. Continue to research the characteristics of various aviation firefighting agents in order to identify the most effective agents and to establish a national standard for aviation firefighting agents.

5. Provide additional emphasis to enhance compliance with the design criteria for aircraft structures and systems so as to locate fuel tank and other critical inspection plates on surface areas that are not vulnerable to debris from failed tires, wheels, and brake assemblies.

6. Require that manufacturers review the antiskid braking system characteristics of large multiengine aircraft, with particular attention to multiple tire or wheel failures and their effect on system operation and overall braking effectiveness. Each manufacturer should provide operators with an analysis of the results of such reviews and suggested procedures for pilot response to tire/wheel failures.

7. Review and amend, as necessary, the criteria established for the number of tire retreads permitted on a single carcass and for the removal of tires from service due to age or number of cycles.

8. Encourage greater use of stronger wheels with roll-on-rim capability for transport category aircraft certified since 1979.

9. Review and modify current flightcrew requirements to include timely training programs that adequately address tire, wheel, and brake problems during takeoff. Motion-based simulators used in the program should have models that provide realistic training in the recognition and handling of such problems.

10. Review and amend, as necessary, the design criteria for large aircraft wheels and tires to preclude sympathetic tire failures occurring after

an initial single tire failure. Considerations should include heavyweight takeoffs and landings.

11. Alert CV-990 operators of potential antiskid failure modes that can result from loss of two tires on the same axle. Determine if any antiskid system with similar logic is operable on other U.S. aircraft and issue an alert.

Department of Defense

1. Review and modify air traffic control procedures so that all military air traffic control towers comply with the provisions of Chapter 3, Section 9, Departure Control Instructions, FAA Air Traffic Control Manual 7110.65.

2. Review current practice to ensure that crash/fire/rescue procedures for alarm room operators include immediate alerting of firefighting personnel in response to an unannounced emergency.

3. Require that firefighters assigned to critical positions be precluded from relief operator assignment.

4. Ensure that all crash/fire/rescue alarm room operators receive hands-on training.

NASA Headquarters

1. Sponsor a study with industry to assess the hazards from blown tires on heavy aircraft. The study should consider the following:

a. Susceptibility of aircraft structure and systems to damage
b. Maximum braking versus limited braking
c. Anomalies of antiskid brake systems
d. Continuing versus rejecting takeoff

2. Evaluate and develop the requirement for flightcrews of large NASA aircraft to receive training in FAA Phase II or Phase III simulators capable of presenting realistic failed-tire models.

3. Evaluate and establish a requirement for incorporation of cockpit resource management training into NASA flight training programs for multicrew-member aircraft.

4. Establish guidelines requiring that only new tires or retreads of NASA tires be used on NASA aircraft.

5. Develop NASA criteria for the number of tire retreads permitted on a single carcass and for the removal of tires from service because of age or number of cycles.

6. Establish guidelines requiring that all occupants of NASA aircraft on research missions wear flight suits made from appropriate fire-retardant materials.

7. Establish a policy to ensure that original designs and manufacturers' blueprints, drawings, etc., of unique equipment onboard NASA aircraft during research missions be retained at appropriate ground facilities. The only existing copies of such materials should not be carried onboard NASA aircraft.

NASA Aircraft Operations Managers

1. Establish procedures for rejected takeoffs that parallel accepted air carrier industry practices, with emphasis on the use of maximum wheel braking and control yoke management.

2. Review the practicality of using wheels with roll-on-rim capability on appropriate NASA aircraft and, if feasible, implement their use.

3. Review the current status of, and need for, structural and cabin fire protection systems on NASA aircraft and, where appropriate, update those systems to incorporate modern detection and suppression devices.

4. Develop guidelines to minimize the use of tires with different ply ratings or tires produced by different manufacturers on the same axle where differences in characteristics between such tires can affect tire loading under normal operating conditions (see National Transportation Safety Board Recommendation A-78-71, addressed to the Federal Aviation Administration, dated 9/6/78).

5. Ensure that copies of pertinent aircraft operational and maintenance logs are retained at appropriate ground facilities.

6. Ensure that preflight inspection records contain the measured tire pressures.

7. Require that all NASA flightcrews monitor the controlling facility radio frequency or appropriate emergency frequency during takeoff.

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15. Supplementary Notes

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16. Abstract

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